

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION

50 California Street • Suite 2600 • San Francisco, California 94111 • (415) 352-3600 • Fax: (415) 352-3606 • www.bcdc.ca.gov

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TO: Commissioners and Alternates

FROM: Will Travis, Executive Director (415/352-3653 travis@bcdc.ca.gov)
Joe LaClair, Chief Planner (415/352-3656, joel@bcdc.ca.gov)

SUBJECT: Status Report on BCDC Climate Science
(For Commission information only)

Summary

The Commission is taking a leadership role to address sea level rise and other global climate change impacts on the Bay and shoreline. Several studies are now underway by the Commission and its partners to gain better understanding of climate change impacts and methods to address them, including: (1) a study of local wetlands in relation to sea level rise; (2) participation in a regional climate science consortium; (3) a regional assessment of the Bay Area's vulnerability to climate change impacts; (4) acquisition of shoreline topographic data to inform analysis of sea level rise inundation; and (5) application of analytical tools to assess potential climate change impacts when adequate data are lacking.

Staff Report

Background. The Commission has directed the staff to provide the Commission with updated information on Commission sponsored research that seeks to more accurately determine future sea level rise and the impacts of climate change on the Bay Area and shoreline. This report satisfies the Commission's strategic plan objective, which states, that "by July 31, 2010 and semi-annually thereafter, the staff will provide the Commission with updated information on the Commission sponsored research that seeks to more accurately determine future sea level rise and the impacts of climate change on the Bay Area and shoreline."

Update

Innovative Wetland Adaptation Strategies. The *Innovative Wetland Adaptation Techniques in Lower Corte Madera Creek Watershed* project is one of the first efforts along the San Francisco Bay shoreline examining how to reduce the vulnerability of tidal wetlands to sea level rise. A diverse team of researchers from both the public and private sector are collaborating on this study. Project team members from the United States Geological Survey (USGS), University of San Francisco, UNESCO-IHE, Sea Engineering Inc., and ESA, PWA are evaluating the current ecosystem services of the tidal wetland system at Corte Madera, Marin County, including the flood control, wave attenuation, and habitat benefits; are assessing the sensitivity of the tidal wetlands to sea level rise in order to determine vulnerability of the system and the services it provides; and developing alternative management measures for inclusion in an adaptation strategy that will improve the resiliency of



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the tidal wetlands to sea level rise in a manner that either enhances or retains the ecosystem services of the system.

Much progress has been made on project management, field data collection, and initial data analysis and modeling. Over the last year proposals were solicited and research teams contracted for three critical pieces of the study (marsh accretion, sediment erosion, and adaptation design). A coordination meeting of all project team members was held in December 2010 to discuss data integration and sharing both among project team members and with other researchers working on sediment source and transport. Outcomes of the meeting will inform the direction of the computer modeling efforts that are part of the study as well as data analysis, interpretation and integration among team members.

Field data was collected and analyzed by the USGS for wave attenuation, bathymetry and coastal topography. The 3-dimensional wave and flood model using Delft3D was developed by UNESCO-IHE and initial calibration and sensitivity runs were conducted. Sediment cores were collected from the intertidal and subtidal mudflat and analyzed for a suite of erosion characteristics by Sea Engineering, Inc. Finally, USF researchers began collecting cores from the vegetated marsh that will be analyzed to determine historic accretion rates and sediment sources.

Next steps for the project include holding a meeting with the project Technical Advisory Committee (TAC); completion of USGS analysis of the wave attenuation and bathymetry/coastal topography data; completion of marsh core collection by USF and installation of vertical accretion measurement stations; development and initial calibration and sensitivity analysis of the 1-Dimension WHAFIS model; and refinement of the Delft3D model.

Bay Area Ecosystem Climate Change Consortium (BAECCC). The Commission's staff is participating in the BAECCC, a group of state and federal and non-governmental organizations that are collaboratively working to identify and addresses climate change impacts on ecosystems by using science to inform adaptive management for long-term ecological and economic benefits (<http://baeccc.org/>). Over the last year BAECCC has clarified that the objectives of the consortium include: (1) Research, Monitoring and Management; (2) Information Management and Sharing; and (3) Policy and Outreach. The BAECCC states that the three ten-year outcomes the group would like to achieve are:

“(1) science-based adaptive management approaches are identified, tested, implemented, and disseminated to reduce negative impacts of climate change and variability on coastal and ocean ecosystems as well as human communities; (2) natural resource management protocols, plans, policies, regulations and statutes are revised and developed to prioritize greatest ecological response to increasingly unpredictable climate and greater extremes than experienced in the past century; and (3) San Francisco ocean-estuary ecological systems have an enhanced ability to respond to rapid climate change to sustain ecological services on which our coastal communities rely. ”

BAECCC has secured two years of funding for an executive coordinator to help manage the consortium's projects and programs.

Regional Vulnerability Assessment. The Commission staff is working with the California Energy Commission's Public Interest Energy Research (PIER) program to help guide a regional assessment of Bay Area climate impacts, vulnerabilities and adaptation strategies. A team of experts headed by Dr. Michael Hanemann, a UC Berkeley Chancellor's Professor in the Department of Agriculture and Resource Economics and an international expert on environmental economics, water management and related subjects, is preparing a report summarizing the current knowledge about Bay Area climate impacts. The impacts report, scheduled for release in February 2011, will consist of 10-15 page chapters on topics including:

- Climate scenarios for the Bay Area
- Sea level rise
- Water management
- Residential energy demand
- Energy supply infrastructure
- Transportation infrastructure
- Public health
- Agriculture
- Biodiversity and ecosystem services
- Inland fisheries

The impacts report will be followed by a report containing new research on specific Bay Area climate vulnerability and adaptation topics. This report will include studies of:

- How urban areas may evolve in the nine counties and how this would affect vulnerabilities (Jim Thorne, UCD)
- The probability of coastal flooding in 2050 and 2100 (Peter Bromirski, UCSD)
- The effect of regional water markets in California on water supply for the SF Area (Jay Lund, UCD)
- Connectivity among urban water supply and wastewater systems in the Bay Area as a response to climate change stresses (Michael Hanemann, UCB)
- How climate change will affect the transportation system and its connectivity (Greg Biging, John Radke, UCB)
- The potential for hot spots resulting from high increases in electricity demand disproportionately affecting low income groups (Max Auffhammer, UCB)
- The increase risk of fire with urban development and exploration on how different development patterns may reduce vulnerabilities (Tony Westerling, UCM)
- Climate vulnerability of agriculture (Rebecca Chaplin-Kramer, UCB)
- Vulnerability assessment of public health in Alameda County (Michael Jerrett, UCB)
- Barriers to adaptation planning in the Bay Area (Julie Ekstrom, UCB, Susanne Moser, Susanne Moser Research & Consulting/UCSC)
- Climate adaptation at the local level: Case study of Oakland, California (Pacific Institute)
- Vulnerability and adaptation options for natural ecosystems in the SF Area (David Ackerly, UCB)

Commission staff is working collaboratively to help researchers obtain any needed information from regional and local agencies, and ensure that the results of the PIER-funded research advances policy, engages the region in adaptation planning, and improves the sustainability and resiliency of coastal communities. As part of this effort, planning is underway to hold a regional symposium to share the results of the regional climate impacts report with decision makers and interested stakeholders. To inform future research on regional climate impacts, vulnerabilities and adaptation options, regional partners and researchers will be asked to participate in a post-symposium evaluation of the critical information needs and gaps about regional impacts, vulnerabilities, and adaptation options.

LIDAR and Imagery. The sea level rise modeling by Dr. Noah Knowles of the United States Geological Survey (USGS) provided BCDC with data that was instrumental in preparing BCDC's regional vulnerability assessment *Living With a Rising Bay*. However, a seamless high-resolution surface elevation dataset for the entire region is needed for more advanced planning and analysis. The high-resolution data will be critical in identifying the location, condition and height of existing levees and shoreline protection structures. Ultimately, future planning efforts and maps will be able to more accurately identify vulnerable shoreline areas. BCDC staff has been coordinating with the NOAA Coastal Services Center, the USGS, the California Ocean Protection Council and other

partners to obtain new high resolution topographic (elevation) and multispectral imagery data for Bay shoreline areas. The new data will provide a single comprehensive dataset for the Bay shoreline, from the Suisun Marsh down through the South Bay, up to the ten-meter contour line and should be available in early to mid-2011.

Climate Ready Estuary Pilot. The United States Environmental Protection Agency's (EPA) Climate Ready Estuaries (CRE) program has been working with the San Francisco Estuary Partnership (SFEP), the Commission staff and the EPA's Office of Research and Development's Global Change Research Program on a pilot project to assess key vulnerabilities of the San Francisco estuary to climate change. The assessment takes advantage of significant work that is already underway in the region, particularly on sea level rise, to support further analysis of climate drivers and ecosystem effects.

The initial work focused on a workshop with regional technical experts to identify and describe known stressors and potential climate change impacts. The CRE team next focused on preparing conceptual models for several key potential climate impacts. However, the team quickly realized that there were insufficient data to inform the proposed approach. Instead, the project used an "expert elicitation process," which uses the synthesis of opinions of experts on a subject where there is uncertainty due to insufficient data <<http://en.wikipedia.org/wiki/Data>>. In this case, the regional experts were brought together in a facilitated process held at the Commission's offices, to evaluate several key climate impacts of SLR and climate change. The CRE team has prepared analysis, conclusions and documentation of the expert elicitation, and the draft document will be available by March 2011 for public review.

Regional Sediment Management. Bay sediment dynamics control many estuarine processes, such as locations of tidal flats and marshes, habitat variability, and the productivity of Bay waters. An understanding of sediment dynamics is important to predicting the impact of sea level rise and global climate change on the Bay. Sediments feed tidal flats, wetlands, beaches and shorelines to maintain their elevation in the tidal frame while minimizing erosion and inundation. Decreases in local or regional sediment supply can exacerbate erosion and inundation. Research from the USGS has shown that the Bay is currently experiencing a decreased sediment supply from the Delta region. This decrease from historic levels means that a majority of the sediment flowing to the Bay is now likely supplied from local tributaries.

Regional sediment management (RSM) is an approach to manage sediments within the context of the entire system, including sediment sources, movement and sinks within the system, and exchange with the ocean. The Commission is collaborating with its partners in the Long Term Management Strategy for the Placement of Dredged Sediment in the Bay Region (LTMS)—the United States Corps of Engineers (Corps), EPA, and the San Francisco Bay Regional Water Quality Control Board—as well as with other Bay management and research agencies, organizations and interested parties to prepare a RSM strategy for the Bay. In addition, the Commission is collaborating on specific research initiatives with the LTMS agencies, the California Water Science Center and the Pacific Coastal & Marine Science Center of the USGS, and the San Francisco Estuary Institute (SFEI).

Local Tributary Study. In April 2010, the Commission staff and the USGS, hosted a "State of the Sediment Science Workshop" in Menlo Park. This workshop provided insight into existing research efforts on the Bay and its watersheds and brought together a broad spectrum of scientists, managers and stakeholders interested in sediment issues. The workshop led to the identification of data gaps that could be filled by initial research. Because local tributaries are becoming increasingly important sources of sediment, Commission staff worked with the LTMS, USGS and SFEI to install sediment gauges in two Bay tributaries. Beginning in 2010, water flow and sediment flux data has been collected at Alameda Creek (Alameda County) and Corte Madera Creek (Marin County), at the creek mouth and above the head of tide. The analysis of the data from these gauges will

provide a better understanding of the sediment contribution to the Bay as well as the sediment flux between the creeks and the Bay. A potential outgrowth of this research is to develop a calibrated watershed model for other local tributaries. This predictive model would focus on different watershed characteristics, and explore different precipitation scenarios and resultant sediment yields to the Bay. The gauges have been installed and the research is in its second year of data collection. Commission staff is being updated on a quarterly basis.

Modeling Efforts. Commission staff is also participating in a collaborative effort with the Corps and USGS to develop a 3D hydrodynamic, wind wave, and sediment transport model. This calibrated model (UNTRIM) will be applied to the SF Bay and Delta region to evaluate the existing aquatic disposal sites, future shoaling conditions and potential changes in the Corps' dredging program. Initial efforts are focused on the North Bay. Using existing data, this modeling initiative will further inform staff understanding of regional watershed sediment influx, Golden Gate sediment flux, bottom sediment characteristics, wave induced sediment re-suspension effects, wetland induced sediment sinks, and the sediment transport modeling system. The integration of the three modeling components will be complete at the end of January 2011. Next steps include calibrating the model with the existing data and developing scenarios for modeling efforts.

Provenance Study. As part of efforts to better understand the origin of fine and coarse grain sediment and thereby sediment transport mechanisms, Commission staff partnered with the USGS and the USACE on a study of Bay sediment mineral and biological markers. The coarse grain sediment work will be completed in 2012. This study will assist staff in understanding the nature of the sand resources in the Bay and the sources and sustainability of sand mining activities in the Bay. The fine grain analysis will complement the modeling and tributary work, assisting staff in understanding sediment supply and transport for marshes and associated mudflats and subtidal areas. Sample collection for both efforts is complete. Analysis of mineralogy and foraminiferans is underway and should be complete in 2012 for sand and 2013 for fine grain sediment.

Together these three studies will provide insight into shoreline stability and the ability of wetlands to keep up with sea level rise and inform sea level rise adaptation planning.